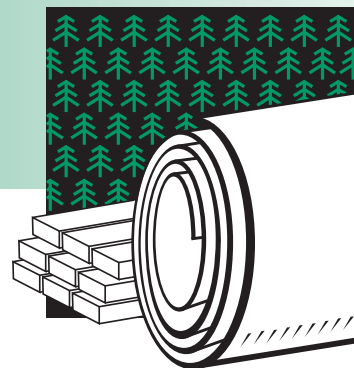


# FOREST PRODUCTS

## Success Story

### LIGNIN SEPARATION AND EPOXIDE-LIGNIN MANUFACTURING



## Environmentally Friendly Polymer Replaces Petroleum-Based Materials

#### Benefits

- ◆ Improves safety of workplace environment due to reduced exposure to formaldehyde
- ◆ Substitutes a renewable environmentally friendly resource for petroleum-derived resins
- ◆ Produces a lower-cost manufacturing resin with improved performance
- ◆ Lowers disposal costs for pulp mills and reduces the amount of black liquor burned, reducing air emissions and costs to comply with environmental laws and air emission ceilings

#### Applications

Resource recovery in pulp and paper industry, which produces resins for the automotive, foundry, plastics, construction, military, furniture, marine, and agricultural industries.

#### Capabilities

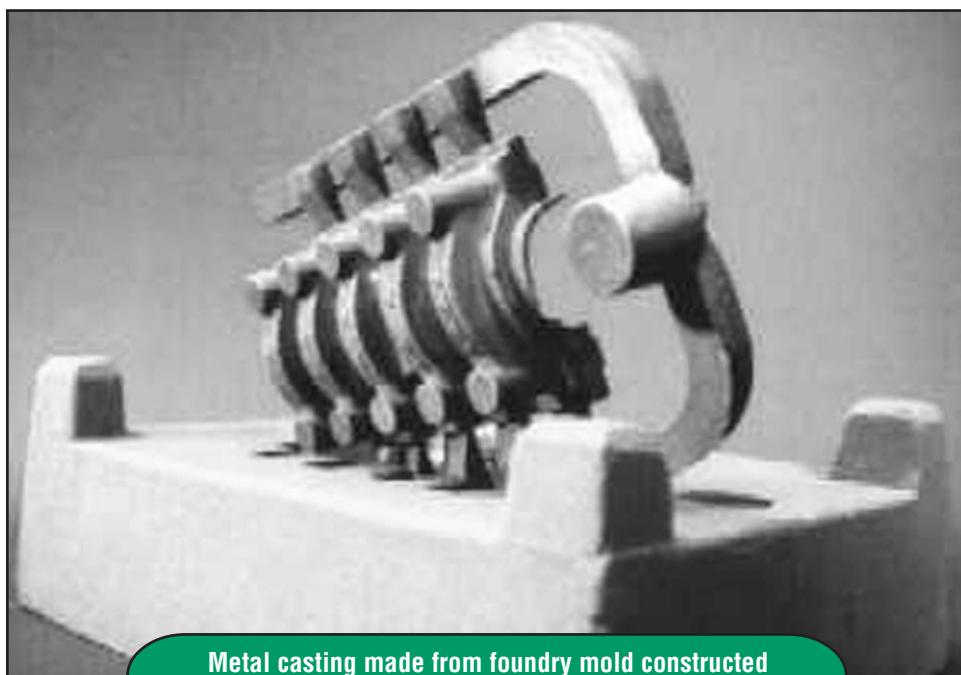
Able to treat black liquor from pulp mills to extract lignin, which is filtered and modified to create manufacturing resins that substitute for urea-formaldehyde, polyester phenolic, and polyurethane resins.

“A majority of inventors aren’t university professors. The I&I Program provides credibility and works with inventors who have industrial experience to help them through the complicated concept to marketplace process.”

— Ken Kurple  
Inventor and founder  
Lenox Resources

Petroleum is a versatile material, a key ingredient in thousands of everyday products, including the plastic found in products ranging from garbage and grocery bags to computers to cars to telephones and even furniture. Unfortunately, using petroleum-based chemicals has several environmental disadvantages. Most notably, the emissions from the manufacture of these products can release toxic by-products like formaldehyde, a suspected carcinogen, into the environment. Further, disposing of these petrochemical based products, which do not break down efficiently, has led to diminishing landfill space.

Ken Kurple, a polymer chemist, founded Lenox Resources, and began searching for a replacement material. With the help from a grant from the U.S. Department of Energy’s Inventions and Innovation Program, Ken developed a process and found a replacement material for petroleum-based resins in a naturally occurring substance found in trees.



Metal casting made from foundry mold constructed of sand and Lenox lignin-based binder



## Technology Description

The pulp and paper industry generates 500 billion pounds of black liquor annually. When a tree is shredded to make wood products, such as paper, the wood fibers are extracted and the leftover material, the black liquor, is normally incinerated as a waste product. Black liquor is an environmentally unfriendly by-product of the paper pulping industry. The tree glue, or lignin, which holds the wood fibers together in the tree, becomes part of the black liquor. Kurple examined this problem and developed a patented process for separating the lignin out and improving its qualities to form a resin viable for manufacturing. Kurple's process reduces the negative impact of black liquor and creates a product with several important environmental advantages.

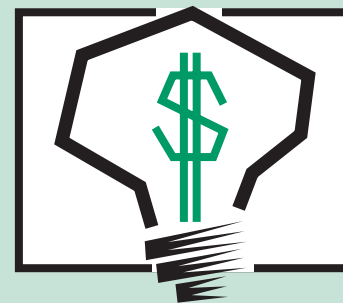
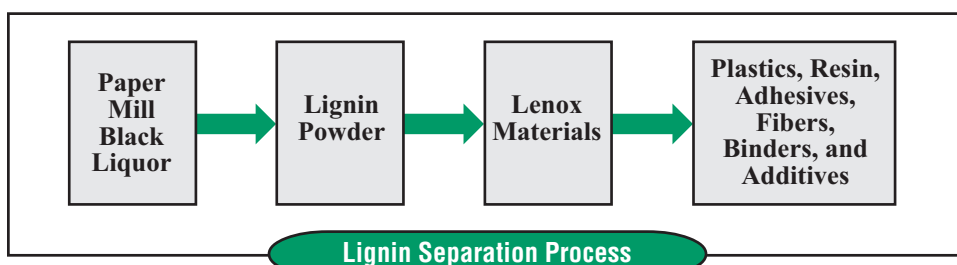
The first step in Kurple's patented process is lowering the pH (alkalinity) of the black liquor and making the lignin insoluble. Then the lignin is filtered out, impurities are removed through a special purification process, and special ingredients are added. The lignin is now in a form suitable for use. Kurple found immediate uses for his new, "natural polymer" (eg., as material used as a building block to produce other products) in the automotive, construction, foundry, urethane foam, packaging and plastics industries.

## Energy Savings and Pollution Prevention

Lenox is teaming with strategic partners in other industries to achieve the optimum economic and environmental impact of its technology in larger, more developed industrial markets. The economic and environmental benefits of a manufacturing facility using Lenox resins are significant. One industrial partner producing a lignin-based plastic with an annual throughput of 1 million lbs could reduce oil consumption by as much as 91,667 gallons per year. For this product application, a lignin-based resin uses 30% less petroleum-derived chemicals than the conventional material. As a result 300,000 fewer pounds of petroleum-based resin would be used annually. For a typical petrochemical based product, approximately 0.3 gallons of oil are necessary to provide the process energy and raw materials to produce one pound of chemical. Based on an energy value of 133,920 Btu/gal for oil, the reduction of 300,000 lb of petrochemicals for production of a lignin-based plastic with an annual volume of 1,000,000 lb/year could save 12.3 billion Btu annually.

## System Economics and Market Potential

Building on its unique understanding of both traditional petroleum-based polymers chemistry and lignin chemistry, Lenox Resources has developed proprietary technologies for using lignin to produce high-performance, high-value plastics. Instead of producing plastics from polymers that are developed from nonrenewable resources such as petroleum and natural gas, Lenox produces plastics using polymers from nature and contained in renewable resources such as trees.



The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and to conduct early development. Ideas that have significant energy-savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

For project information, contact:

### Karl Kurple

Lenox Resources  
3735 Dove Road  
Port Huron, MI 48060  
Phone: (810) 364-3774  
Fax: (810) 364-4286  
info@lenoxpoly.com

Home page:  
[www.lenoxpoly.com](http://www.lenoxpoly.com)

For more information about the Inventions and Innovation Program, contact:

### Lisa Barnett

Program Manager  
Inventions and Innovation Program  
U.S. Department of Energy  
1000 Independence Avenue SW  
Washington, D.C. 20585-0121  
Phone: (202) 586-2212  
Fax: (202) 586-7114  
lisa.barnett@ee.doe.gov

Visit our home page at  
[www.oit.doe.gov](http://www.oit.doe.gov)



Order # I-FP-232  
January 2002